

surface/laminate, through a controlled environment prior to analysis, as shown in **FIG. 1**. In various embodiments of the invention, the environmental chamber **2** includes an environmentally controlled delay line **11**, in order to allow various reactions being performed on the moving surface a given length of time before being assayed. The controlled delay line **11** may include an enclosed pulley system **10**, such that the moving surface **1** travels back and forth in the environmental chamber **2**. Alternatively, the controlled delay line **11** may include a drum that rotates, such that the moving surface **1** travels around the drum in the environmental chamber. The advantage of a delay line **11** comprising a pulley system or drum is that the delay line becomes much more compact than if it were implemented in a linear, elongated conformation. In various embodiments of the invention, the system requires that the drop be held at least in part by surface tension while it hangs for at least some specified period of time at various angles, such as beneath the surface or on its side, during the time it spends on the pulley or drum. In an alternate embodiment, a pulley system is wound such that the belt traverses a path that is horizontal with the pulleys rotating around a vertical axis and the droplets are suspended on the top or bottom of the belt or laminate. In this case, the droplet will tend to slide due to momentum at each turn of the pulley system. Another embodiment includes moving the surface in a spiral configuration, such that the droplets never hang, again momentum becomes an issue. In each of these embodiments, the parameters of droplet size and the energy of the surface interaction between the droplet and the surface of the tape or laminated tape must be chosen such that the droplet is not lost due to gravity and/or momentum. The interaction energy is determined by the material chosen for the surface and the chemical components of the droplet. The droplets may be allowed to slide slightly while being suspended from the side, but not so much that sliding would cause mixing of two or more drops, unless such mixing was desired. If droplets slide slightly during their vertical motion on a drum or pulley system, they will tend to slide an equal amount in the opposite direction on the next half turn of the pulley or drum, thus putting them approximately back where they began prior to the first instance of sliding.

[0079] Due to the propensity of aqueous microdroplets to evaporate, resulting in changes in concentration of analytes and reagents, various measures may be implemented to limit evaporation. At the same time, temperature must be controlled for consistent and optimal chemical, biochemical or biological reactions.

[0080] One means of preventing evaporative loss is to keep those parts of laminate **6** that contain desired microdroplets in a humidified environment, since drops having fluid volumes several microliters or less evaporate rapidly when in a low humidity environment. The relative humidity necessary depends on the size of the microdroplets and the incubation time for the assay, but can be greater than 95%. Humid air may be actively pumped into a substantially sealed environment surrounding the moving surface. A water reservoir may also be placed inside of the sealed environment. Temperature may be controlled by heating either the air in the sealed environment, the moving surface **1** and/or laminate **6** itself, or the water vapor being pumped in. Heat may be applied by various means including resistive heating, infrared light, or microwave radiation.

[0081] In accordance with one embodiment of the invention, a method to maintain a high humidity environment during droplet transport takes advantage of a mechanical guide that laterally constrains the belt, as shown in **FIG. 8**. The belt **94** moves on a support block **95** fits in a groove whose depth is approximately three-quarters the belt thickness. An enclosure **93** consisting of a metal plate with a machined groove fits on top enclosing a volume through which a droplet **91** on the belt's **94** surface is moved. To prevent drop evaporation during transport, the enclosed volume needs to be kept at a constant and high humidity. The groove through which belt **94** moves is partially filled with water **92**. As water **92** evaporates, the water vapor fills the enclosure volume to keep the relative humidity high and constant. Water **92** can be readily injected at one end and transported the length of the groove by the relative friction between belt **94** and water **92** and the mechanical action of the transverse grooves on the bottom side of belt **94**.

[0082] In another embodiment of the invention, the rate of evaporation is reduced by coating the droplets with a substance to limit evaporation. For example, by adding dodecanol or a similar surfactant, a hydrophobic barrier is formed on the outside of the drop to prevent evaporation.

[0083] In alternative embodiments of the invention, certain reagents that are extremely hydrophilic may be added to the droplet to limit evaporation. These include polymers such as polyethylene glycol, gels such as agarose, and small molecules such as glucose.

[0084] The design of the laminate may incorporate features to limit evaporation. The laminate may contain recessed areas, divots or through-holes that reduce the exposed surface area of the droplets. If the laminate is designed so that the drops do not extend past the surface of the laminate, the laminate may be sealed, such as by lamination with a water impermeable material, or covered with a hydrophobic liquid such as octane, decane, dodecane, mineral oil or silicone oil. The hydrophobic liquid should be chosen such that it is sufficiently non-volatile at the working temperature and that desired molecules in the microdroplet do not partition into it. To further limit evaporation of the microdroplets as they are being placed on the laminate, the dispensing heads of the sample delivery devices such as syringe banks may penetrate narrow slots, holes or septa in a humidified track.

[0085] In various embodiments of the invention, it is advantageous to control the amount of time a reaction is allowed to proceed before the drop is assayed. This can be done in four ways. The first is by sampling at different locations in the incubation chamber. The close proximity and regular spacing of the tape loops in the incubation chamber permits scanning of the drops at different times by moving the detector from loop to loop or by using multiple detectors.

[0086] Secondly, a variable path length delay line may be used to vary the sample residence time in the chamber. This can be achieved by moving a bank of pulleys, or by the use of festoons or dancers.

[0087] A third method for varying reaction times is by stopping the reactions at various points in the incubation chamber. For example, a series of eight identical reactions could be placed on the moving surface/laminate in order. A